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Differences in the Fine Motor Performance of Children in Hong Kong and the United States on the Bruininks-Oseretsky Test of Motor Proficiency

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Objective: Cross-cultural differences in motor development is an important issue for occupational therapists to address in the assessment process. The cultural variability of performance in scores interpretation can mislead therapists in their decisions regarding the need for intervention. This study aimed to investigate the differences in fine motor performance on the Bruininks-Oseretsky Test of Motor Proficiency (BOTMP) between school-aged children of Hong Kong and the United States.
Methods: The four fine motor subtests of the BOTMP were administered to a random sample of 264 Hong Kong children aged 6–10 years. The performance scores of participants were compared with those of the American normative samples.
Results: No significant difference was found in the scores between the two groups in Upper Limb Coordination and Response Speed subtests. However, the Hong Kong children performed significantly better in the subtests of Visual-Motor Control and Upper Limb Speed and Dexterity. In addition, significant gender difference was also present in all subtest scores except for the subtest of Upper Limb Speed and Dexterity.
Conclusion: The results suggest that occupational therapists should be cautious of cross-cultural differences when interpreting fine motor performance scores using the BOTMP for Hong Kong school-aged children.

KEY WORDS: Bruininks-Oseretsky Test of Motor Proficiency • Cultural differences • Fine motor performance

Introduction

Fine motor skill is one of the specific components to be assessed by occupational therapists when evaluating children's functional performance at home, in school and at play. In the assessment process, cultural relevancy of the motor test is an important issue for occupational therapists to address as numerous studies have reported significant cross-cultural differences in the motor development of children.

Plimpton & Regimbal (1992) found that child-rearing practices were a factor contributing to the race and gender differences in motor proficiency. They used the short form of the Bruininks-Oseretsky Test of Motor Proficiency (BOTMP) to compare the gross motor skills of 69 African-Americans (38 boys and 31 girls) and 111 Caucasian children (53 boys and 58 girls) who lived in the same metropolitan area of the mid-west of the United States. Results showed that African-American children were faster and more agile than Caucasian

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children. On the other hand, the Caucasian boys scored significantly higher than all other children in hand-eye coordination. The authors pointed out that caution was needed in generalizing the results if socioeconomic status was not controlled for.

Significant cultural differences in motor skills between the children of Japan and America were found in several studies. Saeki, Clark & Azen (1985) compared the visual-motor skills of Japanese, Japanese-American and American children using the Design Copying and Motor Accuracy—Revised Tests of the Southern California Sensory Integration Tests. They found that both groups of Japanese-descent children performed better than the group of American children, in addition, the Japan-born children performed the best. They suggested that the superior performance of Japan-born children, and to a lesser extent the Japanese-American children, might be associated with the cultural emphasis on fine motor skills acquisition in Japanese preschool programmes. They concluded that culture had an influence on the development of a child. On the other hand, Miyahara et al. (1998) also found significant cultural differences in motor performance between Japanese and American children. However, they reported a totally different result from that of Saeki, Clark & Azen's (1985) study. By using the Movement Assessment Battery for Children (Movement ABC), they found that the Japanese children were good at dynamic balance, while the American children were good at manual dexterity. Besides, the Japanese children had reached the ceiling scores in some of the items, especially in the balance category. The authors pointed out that these early reaching of ceiling scores affected the discriminative power of the Movement ABC for children in the Japanese population.

In a recent study conducted in Hong Kong, Chow, Henderson & Barnett (2001) also found that Hong Kong preschoolers performed significantly better in dynamic balance, while American children performed better in projection and reception of moving object. In addition, the Hong Kong children were superior to the American children in manual dexterity tasks especially in the test items "Drawing Trails" and "Posting Coin". According to Chow, Henderson & Barnett (2001), this might be due to the early exposure to fine motor and handwriting tasks in their preschool education.

Gender differences in motor development have also been well documented in both Eastern and Western cultures (Aponte, French & Sherrill, 1990; Broadhead & Bruininks, 1982; Chow, Henderson & Barnett, 2001; Duger et al., 1999). These gender differences might be the result of various factors such as skeletal differences, sex-related role expectations, and social acceptance, etc. Duger et al. (1999) mentioned that throwing patterns were better in boys than girls at age 5, while girls were usually better at fine motor tasks than boys in the fifth and sixth years. They also pointed out that the ability to modify sex-related motor behaviours was apparent in kindergarten children and increased steadily with age, indicating that at least a portion of the behaviour was learned, rather than being an inherent gender difference. By reviewing the literature and considering the unique sociocultural circumstances of Hong Kong, a difference in fine motor skills performance was expected between Hong Kong and American children, as well as between boys and girls in Hong Kong.

In light of the observed cross-cultural difference in motor performance, the relevance of the American norms of the BOTMP for measuring the fine motor skills of Hong Kong children was being questioned although it is one of the standardized motor assessments commonly used by occupational therapists in Hong Kong (Chan, 2006; Lai et al., 2006).

The BOTMP is a norm-referenced standardized test developed by Bruininks (1978), from a sample of 800 American children, to screen or assess the motor skills of children aged 4.5–14.5 years. The instrument consists of eight subtests comprising 46 items. Subtests 1, 2, 3 and 4 measure gross motor skills, subtests 6, 7 and 8 measure fine motor skills, while subtest 5 measures both gross and fine motor skills. The first four subtests provide the Gross Motor Composite and last three subtests provide the Fine Motor Composite. The standard scores of the eight subtests contribute to a battery composite which is an index of general motor proficiency.

Bruininks (1978) described the reliability and validity of the BOTMP in the manual, moderate to high correlations were reported for internal consistency of the subtests, indicating that the individual items were related with the subtest scores and total test scores. For the gross motor and fine motor composite scores, satisfactory coefficients for test–retest reliability ranging from 0.68 to 0.88 were reported for a sample of 63 second graders and 63 sixth graders. For separate subtests, the test–retest reliability coefficients ranged from 0.58 to 0.89 for grade two students and 0.49 to 0.89 for grade six students except in Upper Limb Coordination (subtest 5). Bruininks (1978) explained that the low reliability (0.29) in subtest 5 for grade six students was due to the fact that the subjects had reached maximum or near maximum point scores. The interrater reliability of the BOTMP was only obtained in Visual-Motor Control (subtest 7) and the coefficient ranged from 0.77 to 0.97. Wilson et al. (1994) pointed out that the lack of study of interrater reliability on other subtests posed a major limitation to the use of the BOTMP. To support the validity of the BOTMP, Bruininks (1978) reported high correlations between the subtest point scores and chronological age, ranging from 0.57 to 0.86 with a median of 0.78. Three studies comparing the performance of children with and without mental or learning disabilities

were also reported in the manual. The results of all three studies were statistically significant to differentiate the motor performances between the normal and handicapped subjects.

Other studies have been done to review the clinical usefulness of BOTMP. Hattie & Edwards (1987) described the presence of gender differences, low item consistency, high standard errors of measurement, and limited usefulness in grouping subtests. However, they supported the use of the BOTMP as a diagnostic tool, provided that it should be applied with caution. In investigating the clinical usefulness of the BOTMP, Wilson et al. (1994) found that four subtests: Running Speed and Agility (subtest 1), Balance (subtest 2), Visual-Motor Control (subtest 7), and Upper Limb Speed and Dexterity (subtest 8) provided a greater degree of discrimination between children with and without motor problems. They supported the BOTMP as an appropriate descriptive measurement tool for the motor abilities of children and as an evaluation instrument to document progress, while pointing out its limitations of undefined inter-rater reliability and lacking studies on sensitivity between the BOTMP and other evaluative instruments.

This study aimed to investigate the differences in fine motor performance between school-aged children of Hong Kong and the United States by using the BOTMP. We hypothesized that the school-aged children of Hong Kong would obtain higher scores on all the fine motor subtests than the American children. The reliability and validity of the BOMPT for Hong Kong children were also be examined. The gender difference in the Hong Kong sample was investigated. The results might provide further information concerning cross-cultural issues of motor skills and cultural relevancy of applying the BOTMP for Hong Kong children.

Methods

Sample

Based on the performance scores of the BOTMP collected from 21 children aged 6–10 years in the pilot study, power analysis was conducted with alpha at 0.05 (1-sided) and power of the study at 80%. The sample size for a year-age group in subtests 5 and 6 was 90, and in subtests 7 and 8 was eight. The small sample size calculated in subtests 7 and 8 was due to the large discrepancy in performance between the pilot study and the American norm. This phenomenon was also observed in the authors' daily clinical practice. Based on the calculated sample size of subtests 5 and 6, a total sample of 360 children for four age groups (6–7 years, 7–8 years, 8–9 years, 9–10 years) was planned for recruitment in the study.

Ten primary schools were randomly selected from the primary school list of the Education and Manpower Bureau. From each school, nine children from each age group (6–7 years, 7–8 years, 8–9 years, 9–10 years) were randomly selected from the class registers. Participation of children in the study was confirmed with parental consent. Demographic data of the subjects and their family background were collected by a questionnaire. Children with developmental problems on sensory, physical and intellectual aspects according to the school records and parents' reports were excluded.

Due to time constraints, the data collection procedures for the subjects of the last two schools were not completed. A total of 264 children (128 boys and 136 girls) were finally included in the study. Parents had the following self-reported educational experiences: 19.6% had post-secondary education, 69% had secondary education, and 11.4% had primary education or below.

Instrument

Fine motor subtests (5 to 8) of the BOTMP were administered in this study since the authors wished to focus on the Fine Motor Composite first. Nine items of subtest 5 (Upper Limb Coordination) assess coordination of visual tracking with movements of arms and hands as well as the precise movements of arms, hands, or fingers. One item of subtest 6 (Response Speed) measures the ability to respond to a moving visual stimulus. Eight items of subtest 7 (Visual-Motor Control) measure the ability to coordinate precise hand and visual movements. Eight items of subtest 8 (Upper Limb Speed and Dexterity) measure hand and finger dexterity, hand speed, and arm speed.

As the instrument was administered to Hong Kong children whose mother language is Cantonese, the instructions were first translated into Cantonese by an experienced paediatric occupational therapist. The translated instructions were then evaluated by an expert panel of six experienced paediatric occupational therapists. The fluency and equivalence of semantic meaning of the Chinese translated instructions were rated by a 4-point Likert Scale with "4" being strongly agree and "1" being strongly disagree. The mean ratings ranged from 3.46 to 3.83 and from 3.44 to 3.83 for fluency and semantic meaning, respectively.

Procedure

Five occupational therapists from the Child Assessment Services, Department of Health, each having more than 10 years paediatric experience, participated in the test administration. Testing was conducted in the large classrooms or function rooms of the schools. All children were tested with the BOTMP individually. The testing took approximately 35–45 minutes depending on the response of each child. The performances of the children were scored according to the test manual (Bruininks, 1978).

Interrater Reliability

Since videotaping was not allowed in most schools, it was difficult for five raters to assess a child at the same time. Therefore, in this study, the raters were paired up randomly and scored a child's performance on the BOTMP simultaneously. Each rater was blinded to the scoring of the other rater. Each pair of raters observed and scored eight children, with a total of 24 children being tested for the interrater reliability. One rater was absent in the testing as she was on her maternity leave at that time.

Data Analysis

One sample *t* test was used to examine group differences between the American and Hong Kong children on subtests 5, 6, 7 and 8 of the BOTMP. Two-way ANOVA was applied to assess the effects of age and gender on the performance of subtests. Scheffe's *post hoc* test was conducted to identify which specific age groups had statistically significant differences. The intraclass correlation coefficient (ICC) was used to determine interrater reliability.

Results

Figure 1 shows the mean of both Hong Kong and American children in subtests 5, 6, 7 and 8; while Table 1 presents the results of the *t* test. As shown in Table 1, there was no significant difference between the Hong Kong and American children in Upper Limb Coordination (subtest 5) except in subtest 5 for the 8.5–9.4 year group ($p \leq 0.001$), where the American children performed significantly better than the Hong Kong children. For Response Speed (subtest 6), there was no significant difference between the Hong Kong and American children for all age groups. On the other hand, for the Visual-Motor Control (subtest 7) and Upper Limb Speed and Dexterity (subtest 8), Hong Kong children showed significantly better performance than American children in all age groups ($p \leq 0.001$).

Table 2 shows the Hong Kong children's mean scores and standard deviations for subtests 5, 6, 7 and 8 of the BOTMP. Generally, the scores increased as the children's age increased

Table 1. Results of *t* test comparison between Hong Kong and American samples

Age (yr)	BOTMP			
	Subtest 5 *t*	Subtest 6 *t*	Subtest 7 *t*	Subtest 8 *t*
6.5–7.4	1.89	0.47	10.29*	8.39*
7.5–8.4	1.14	0.46	7.11*	5.52*
8.5–9.4	4.18*	0.85	5.54*	4.58*

*$p \leq 0.001$. Subtest 5 = Upper Limb Coordination; Subtest 6 = Response Speed; Subtest 7 = Visual-Motor Control; Subtest 8 = Upper Limb Speed and Dexterity.

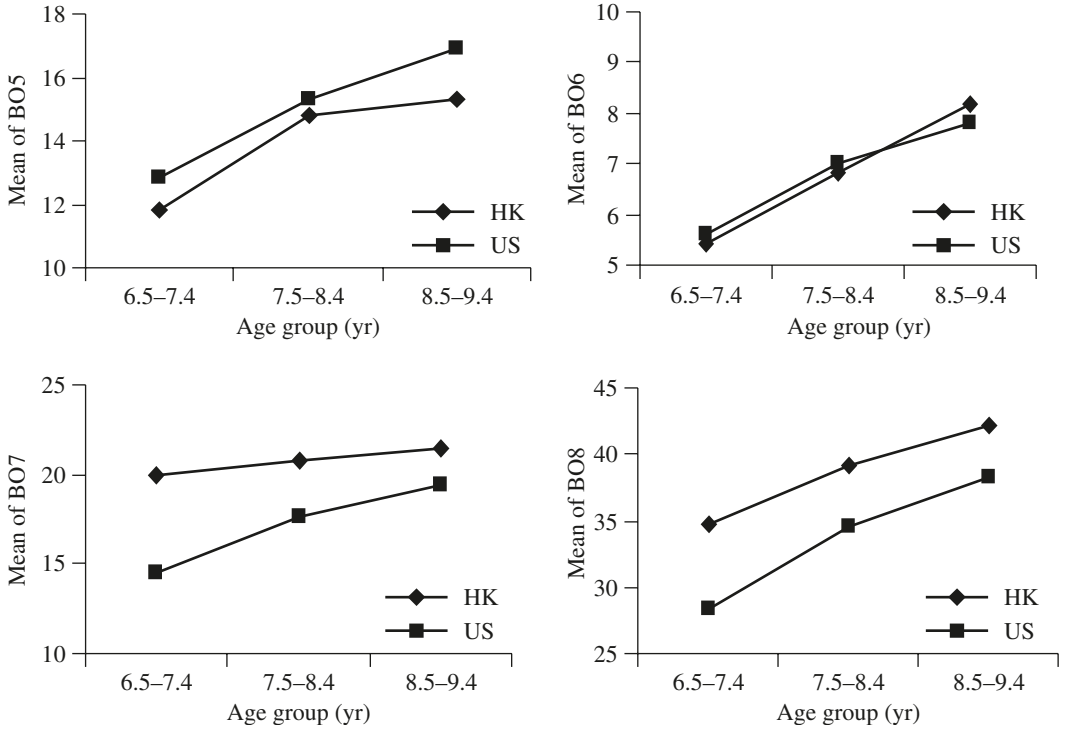

Figure 1. *Mean scores for Hong Kong and American samples (age interval = 1 year). (American data from p. 26 of the BOTMP Manual.)*

Table 2. Mean scores (standard deviations) for Hong Kong samples*

Age (yr)	*n*	BOTMP											
		Subtest 5 Mean (SD)			Subtest 6 Mean (SD)			Subtest 7 Mean (SD)			Subtest 8 Mean (SD)		
		Total	Boy	Girl	Total	Boy	Girl	Total	Boy	Girl	Total	Boy	Girl
6.0–6.9	60	10.87 (3.85)	12.54 (3.68)	9.41 (3.43)	4.85 (2.61)	5.68 (2.89)	4.13 (2.12)	19.00 (2.15)	18.57 (2.27)	19.38 (2.00)	32.90 (5.41)	34.29 (5.74)	31.69 (4.87)
7.0–7.9	67	13.48 (3.69)	13.16 (4.34)	13.75 (3.06)	6.07 (2.80)	6.58 (2.77)	5.64 (2.80)	20.52 (2.13)	20.29 (2.31)	20.72 (1.98)	37.66 (5.03)	37.81 (5.09)	37.53 (5.04)
8.0–8.9	73	14.79 (2.61)	14.80 (3.00)	14.79 (2.24)	7.44 (2.52)	7.71 (2.80)	7.18 (2.23)	21.21 (1.96)	20.60 (1.94)	21.76 (1.82)	40.45 (4.57)	40.06 (5.08)	40.82 (4.07)
9.0–9.9	64	16.30 (2.39)	16.56 (2.52)	16.00 (2.23)	8.69 (2.40)	9.56 (2.16)	7.70 (2.31)	21.63 (1.59)	21.29 (1.64)	22.00 (1.46)	43.56 (5.09)	42.76 (4.75)	44.47 (5.37)

*The mean scores (standard deviations) for the Hong Kong samples were further broken down into half-year age range for clinical use (Appendix). Subtest 5 = Upper Limb Coordination; Subtest 6 = Response Speed; Subtest 7 = Visual-Motor Control; Subtest 8 = Upper Limb Speed and Dexterity.

in all subtests. In Visual-Motor Control (subtest 7), a plateau of performance was noted as early as 8 years old.

By analysing the data of the Hong Kong children with ANOVA, there was no significant difference among different geographical areas, i.e. Hong Kong Island, Kowloon, New Territories, in the performance of subtest 5 [$F(2,261)=0.20$, $p=0.821$], subtest 6 [$F(2,261)=0.06$, $p=0.938$], subtest 7 [$F(2,261)=2.20$, $p=0.115$], and subtest 8 [$F(2,261)=1.44$, $p=0.240$].

Table 3 summarizes the results from two-way ANOVA in which age and gender were entered as between-subject variables. There was a significant effect of age for all subtests. In addition, significant effect of gender was also noted in subtests 5, 6 and 7. The analyses revealed no significant interaction effect between age and gender in most subtests except in Upper Limb Coordination (subtest 5).

Figure 2 illustrates the mean scores of girls and boys for the different subtests. Boys were generally better than girls in Upper Limb Coordination (subtest 5) and Response Speed (subtest 6). On the other hand, girls were better in Visual-Motor Control (subtest 7).

The *post hoc* comparison by Scheffe's test was used to determine the differences among different age groups in different subtests; the results are shown in Table 4. For subtest 8, significant difference was noted between each age group.

Regarding the reliability of the BOTMP, the ICCs for subtests 5, 6, 7 and 8 ranged from 0.85 to 0.99, 0.96 to 1.00, 0.80 to 0.91, and 0.95 to 0.99, respectively. These ICCs indicated high interrater agreement for subtests 5, 6, 7 and 8 of the BOTMP.

The internal consistency of subtests 5, 7 and 8 of the BOTMP was investigated using Cronbach's (1951) coefficient alpha. Correlations between individual items and their subtest scores are shown in Table 5. Both the Upper Limb Coordination (subtest 5) and Upper Limb Speed and Dexterity (subtest 8) demonstrated acceptable reliability as their coefficient alpha reached 0.70 in most age groups. On the other hand, a relatively

Table 3. Age, gender and interaction effects on subtests 5, 6, 7 and 8 of the BOTMP (two-way ANOVA)

BOTMP	F		
	Age	Gender	Age × Gender
Subtest 5	32.65*	4.10†	4.32‡
Subtest 6	25.72*	15.33*	0.95
Subtest 7	22.44*	10.48*	0.43
Subtest 8	50.66*	0.03	2.13

*$p \leq 0.001$; †$p \leq 0.05$; ‡$p \leq 0.01$. Subtest 5 = Upper Limb Coordination; Subtest 6 = Response Speed; Subtest 7 = Visual-Motor Control; Subtest 8 = Upper Limb Speed and Dexterity.

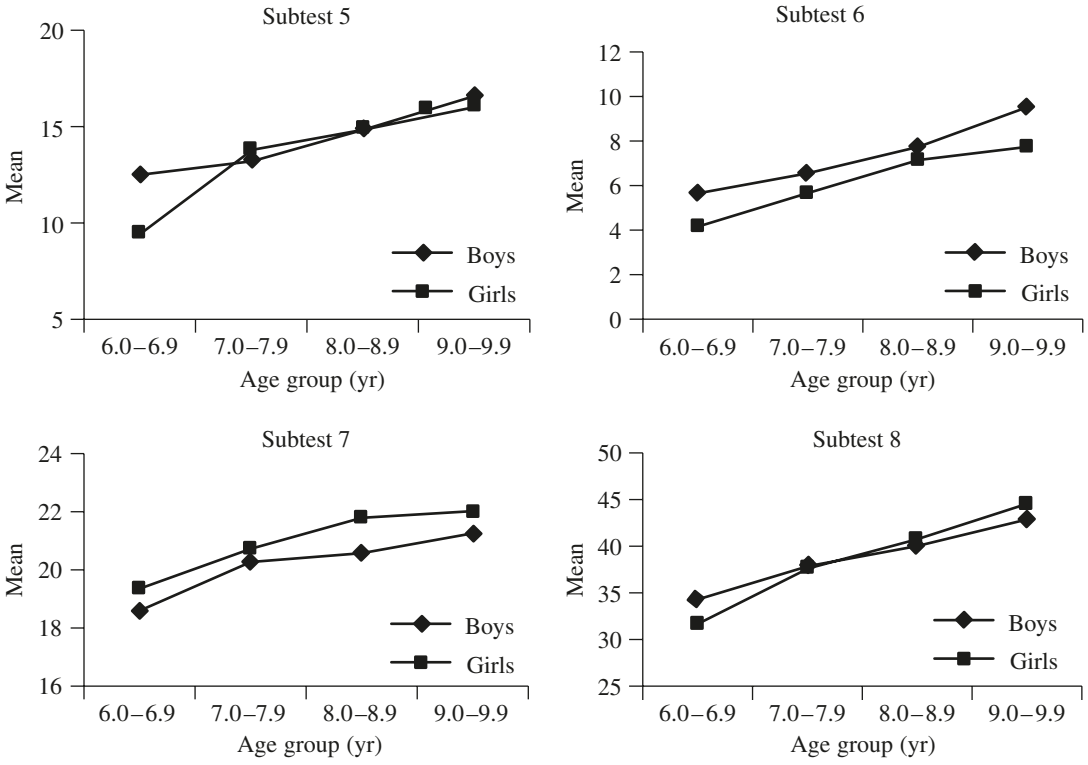

Figure 2. *Mean scores for girls and boys by age group (Hong Kong samples).*

Table 4. *Post hoc* comparison (Scheffe's test) of age on subtests 5, 6, 7 and 8 of the BOTMP

BOTMP	Age (yr)			
	6.0–6.9	7.0–7.9	8.0–8.9	9.0–9.9
Subtest 5				
6.0–6.9 yr		0.000	0.000	0.000
7.0–7.9 yr			0.101	0.000
8.0–8.9 yr				0.049
9.0–9.9 yr				
Subtest 6				
6.0–6.9 yr		0.061	0.000	0.000
7.0–7.9 yr			0.018	0.000
8.0–8.9 yr				0.041
9.0–9.9 yr				
Subtest 7				
6.0–6.9 yr		0.000	0.000	0.000
7.0–7.9 yr			0.230	0.015
8.0–8.9 yr				0.0661
9.0–9.9 yr				
Subtest 8				
6.0–6.9 yr		0.000	0.000	0.000
7.0–7.9 yr			0.013	0.000
8.0–8.9 yr				0.005
9.0–9.9 yr				

Subtest 5 = Upper Limb Coordination; Subtest 6 = Response Speed; Subtest 7 = Visual-Motor Control; Subtest 8 = Upper Limb Speed and Dexterity.

Table 5. Coefficient alphas for subtests 5, 7 and 8 of the BOTMP

BOTMP	R			
	6.0–6.9 yr	7.0–7.9 yr	8.0–8.9 yr	9.0–9.9 yr
Subtest 5	0.74	0.73	0.69	0.70
Subtest 7	0.66	0.67	0.70	0.63
Subtest 8	0.74	0.71	0.70	0.71

Subtest 5 = Upper Limb Coordination; Subtest 7 = Visual-Motor Control; Subtest 8 = Upper Limb Speed and Dexterity.

weaker reliability was noted in subtest 7, although the coefficient alpha still lay between 0.60 and 0.70 in all age groups.

Discussion

The performance of 264 Hong Kong children on subtests 5, 6, 7 and 8 of the BOTMP in the present study was analysed and compared with the performance of American children. Among the four subtests, it was noted that the Hong Kong children performed significantly better in Visual-Motor Control (subtest 7) and Upper Limb Speed and Dexterity (subtest 8) than the American children. However, no significant difference was noted in Upper Limb Coordination (subtest 5) and Response Speed (subtest 6) between the two populations.

The present results are consistent with those of Chow, Henderson & Barnett (2001), who found that Chinese children were significantly better than American children on manual dexterity. In addition, Saeki, Clark & Azen (1985) also reported that Japanese children were significantly better than American children in some visual-motor control tasks. Similar to the present finding, Opper's study (1996) also found that Hong Kong children were 1–2 years in advance of American children in drawing and writing skills such as drawing a man, writing their names and numbers. The superiority of Hong Kong children in fine motor skills may be explained by their early exposure to fine manipulation tools such as chopsticks and pencils. In Hong Kong, it is not rare for children to start holding a pencil and learning to write at 3 years of age, as well as start to use chopsticks as early as 2 years of age. There is also an enormous amount of handwriting tasks in Hong Kong children's school and even their preschool life. As children learn bilingually in Hong Kong, they need to write both English words on lined paper and complex Chinese characters within small grids. Tseng & Hsueh (1997) mentioned that pen-lifts and sharp turns, which require precise pencil control, are usually needed in writing Chinese. The early practice in handwriting as well as the complex pencil control required in writing Chinese characters may be one of the reasons for the advance in the fine motor skills of Hong Kong children compared to American children.

There was no significant difference between Hong Kong and American children in Response Speed (subtest 6), which measures the ability to respond quickly to a moving visual stimulus. Tabatabainia, Siviani & Maas (1995) mentioned that this subtest only requires a rapid movement of the thumb to stop a falling stick and thus could be labelled as a "simple pattern of movement". This quick and simple visual-motor response is automatic in nature and should not be affected by any sociocultural factor.

For Upper Limb Coordination (subtest 5), which assesses both the coordination of visual tracking with movements of the arms and hands and also the precise movements of the arms, hands and fingers, the American children generally performed better than the Hong Kong children, although significant difference was only noted in the older age group (8.5–9.4 years old). Subtest 5 has a strong component of ball skills, which are present in five of nine items in this subtest. Chow, Henderson & Barnett (2001) also reported that American children were better than Hong Kong children on projection and reception of moving objects (balls and bean bags) in a group of 4–6-year-old children. The American children seem to be consistently in advance of Hong Kong children, of both preschool-aged and school-aged, in this area. Again, this was no surprise in view of the heavy emphasis on academic skills in Hong Kong (Chan, 1996; Opper, 1996), which might be to the detriment of ball skills and even other gross motor skills for Hong Kong children. In addition, the crowded living environment in Hong Kong does not favour the development of ball skills in local children.

In this study, the children were selected from all three officially designated areas of Hong Kong, i.e. Hong Kong Island, Kowloon and the New Territories. According to the results, there was no significant difference in performance among the different geographical areas. It further supports the finding of Chow, Henderson & Barnett (2001), who also noted that different geographical areas did not make any difference on the motor skills of preschool children.

On the other hand, a significant age effect was noted in subtests 5, 6, 7 and 8 of the BOTMP in Hong Kong children. Therefore, it is important to refer to separate age norms for each subtest in the BOTMP manual when interpreting an individual child's performance. Duger et al. (1999) pointed out that motor performance steadily improved with age until adolescence. For Visual-Motor Control (subtest 7), significant difference was only noted in the younger age groups but not in the older age groups (8.0–8.9 and 9.0–9.9 years old). It was noticed that Hong Kong children already scored 21 out of 24 marks in subtest 7 at the early age of 8 years. According to Opper (1996), Hong Kong children can write the numbers 1 to 25 and copy a variety of shapes including triangle, square and simple words at 4 years of age. In addition, they can write their Chinese names, which include complex pen strokes, at 5 years of age, and can even copy a complex shape such as a diamond shape. Subtest 7 included items such as cutting out a circle, drawing a line through curved paths and copying geometric shapes, which seemed to be too easy for Hong Kong children. Therefore, the discrimination effect of this subtest for the older children in Hong Kong is being queried. Therapists should be cautious especially when interpreting children's performance with subtest 7 of the BOTMP.

In this study, significant gender difference was noted in subtests 5, 6 and 7. Boys were better than girls in Upper Limb Coordination (subtest 5), which included many ball-throwing items, and Response Speed (subtest 6). On the other hand, girls performed better than boys in Visual-Motor Control (subtest 7), which was partly contributed by fine motor control. Duger et al. (1999) also mentioned a similar phenomenon in that boys were better in throwing patterns and girls were better in fine motor skills, but the results were found in different age groups. According to the results of this study, gender difference should be considered when evaluating motor skills in Hong Kong children, especially for subtests 5, 6 and 7 of the BOTMP. Therefore, the establishment of a set of gender-specific norms

is urgently required. Davies & Rose (2000) also criticized the BOTMP for its limited use that separate composite standard scores for boys and girls were only provided as supplementary tables, whilst the test manual itself only referred to these tables as optional. The test manual did not discuss the existence of gender differences; however, examinations of individual means and standard deviations, for boys versus girls in each subscale, indicated that differences were likely to exist.

An interaction effect only existed between age and gender on Upper Limb Coordination (subtest 5). Boy and girl differences at a younger age group in subtest 5 was noted to be larger, e.g. at 6.0–6.9 years old, the mean for boys was 12.54 ± 3.68 and the mean for girls was 9.41 ± 3.43. Therefore, we should interpret the performance of this group of children by considering both age and gender effects.

In the BOTMP manual, interrater reliability was evaluated only for Visual-Motor Control (subtest 7) and not for the other subtests, and it was reported to range from 0.77 to 0.97 for individual test items (Bruininks, 1978). In this study, a high interrater reliability for subtests 5, 6, 7 and 8 was noted. Among the four subtests, the highest interrater reliability was in Response Speed (subtest 6), and the finding was obvious since it only required a direct observation of where the child's thumb had touched the ruler. In Visual-Motor Control (subtest 7), some items required the rater to score the copied shapes. Since the scoring criteria for the scores of 0, 1 and 2 were not clearly defined, this might have been a major source of the lowest interrater reliability among the four subtests, although it still had a reasonably high ICC (> 0.8).

The Upper Limb Coordination (subtest 5) and Upper Limb Speed and Dexterity (subtest 8) of the BOTMP showed an acceptable internal consistency for the Hong Kong children. This meant that the functions being measured within subtests 5 and 8 were related to each other, or the subtests were relatively homogeneous. However, the internal consistency of the Visual-Motor Control (subtest 7) was relatively lower. In subtest 7, items 1 to 4 were scissoring and tracing tasks that mainly tapped eye-hand coordination skills. Items 5–8 were design-copying tasks with a heavy component on visual perceptual skills instead of using simple eye-hand coordination skills. Since visual perception and eye-hand coordination are two different abilities in a child, this might explain the weaker internal consistency for subtest 7.

Conclusion

Our study suggests that there are differences in the fine motor scores of the BOTMP between normal children in Hong Kong and those in the United States. When compared with the children in the States, the children in Hong Kong perform better in the control of Upper Limb Speed and Dexterity as well as Visual-Motor Control. The positive findings on interrater reliability and internal consistency supported the BOTMP as being a reliable tool for assessing the fine motor skills of Hong Kong children. However, occupational therapists should address this cultural difference when interpreting the fine motor scores of the original American norm-referenced BOTMP for Hong Kong children, and be cautious that children with mild fine motor problems are not under-diagnosed, resulting in the missing out of any necessary intervention. The gender difference in fine motor performance is an additional issue for consideration in evaluating the fine motor skills of school-aged children. The establishment of gender-specific normative data is worth further study. Considering the early plateau in the performance of the Visual-Motor Control subtest, further research of the BOTMP is recommended to investigate its discriminative power when used in older school-aged children.

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Appendix. Mean scores (standard deviations) for Hong Kong samples (half-year age range)*

Age (yr)	*n*	BOTMP			
		Subtest 5 Mean (SD) Total	Subtest 6 Mean (SD) Total	Subtest 7 Mean (SD) Total	Subtest 8 Mean (SD) Total
6.0–6.5	22	9.45 (3.62)	4.27 (2.27)	17.77 (2.18)	32.18 (6.67)
6.6–6.9	38	11.68 (3.79)	5.18 (2.76)	19.71 (1.80)	33.32 (4.57)
7.0–7.5	32	12.00 (3.51)	5.72 (2.65)	20.38 (2.30)	36.25 (5.39)
7.6–7.9	35	14.83 (3.36)	6.40 (2.93)	20.66 (2.00)	38.94 (4.36)
8.0–8.5	36	14.72 (2.74)	7.17 (2.50)	21.03 (2.08)	39.53 (4.55)
8.6–8.9	37	14.86 (2.52)	7.70 (2.54)	21.38 (1.85)	41.35 (4.46)
9.0–9.5	34	15.85 (2.36)	8.82 (2.74)	21.53 (1.58)	43.12 (5.01)
9.6–9.9	30	16.80 (2.35)	8.53 (2.00)	21.73 (1.62)	44.07 (5.21)

*Separate norms for boys and girls in half-year age range were not provided due to the small sample size. Subtest 5 = Upper Limb Coordination; Subtest 6 = Response Speed; Subtest 7 = Visual-Motor Control; Subtest 8 = Upper Limb Speed and Dexterity.